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PATENT SPECIFICATION

910,425

DRAWINGS ATTACHED.



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COMPLETE SPECIFICATION.

Improvements in or relating to Methods of Fusing Together Two Plastic Components.

I, WALTER ALLEN PLUMMER, of 3546 Crownridge Drive, Sherman Oaks, California, United States of America, Citizen of the United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to methods of fusing together two plastic components and is concerned with methods of fusing together two plastic components of different shore hardness. In particular this invention relates to thin-walled plastic articles and methods of fabricating the same and more particularly to an improved technique for heat sealing separate components of thin flexible plastic together and to the product

15 formed thereby.

20 According to one aspect of the invention there is provided a method of fusing together two plastic components having differing shore hardness characteristics comprising cooling the component of lower shore hardness and then heat sealing the two components together while the component of lower shore hardness is in the cooled condition.

25 It will be understood that the principles of the invention are generally applicable to the fabrication of numerous articles and products including as constituent elements thin layers of supple, flexible plastic difficult to handle and control while being fused together by prior heat sealing techniques. The problems presented are generally illustrated by those experienced in fabricating such an article as seamed plastic tubing now widely

30 used to enclose duct systems cabling, wire trunks having branch-outs and many other

similar applications. Such tubing typically comprises a thin plastic main body of either laminated or single-ply material provided along its opposite lateral edge areas with plastic slide fastener tape heat sealed thereto, these tapes being provided with inter-fitting joint elements co-operating to form a longitudinal seam which may be quickly opened or closed for various purposes. Such plastic tubing as heretofore made has not been entirely satisfactory owing to difficulties encountered in providing a strong and uniform heat seal between the thin flexible tape elements and the equally thin, supple and distortable main body strip which tends to become displaced from the desired position of the parts for the heat sealing assembly thereof. The reasons for these assembly difficulties vary. For example, the plastic slide fastener tape elements commonly used in these assembly operations are customarily formed by the extrusion process and seldom are obtainable in straight flat form. Instead these elements are replete with undulations, curls, waves and other distortions rendering the same difficult to handle and to maintain in a desired aligned relation with the element to which they are to be fused. Even where means are provided for holding the tape elements rigidly aligned during heat sealing, upon release of the holding pressure the tapes tend to return to the previous curled and distorted state. This result not only provides a product which is unsightly and non-uniform in appearance but leads to the malfunctioning of the seam and the premature failure of the seam during use. The warped and undulating appearance of the slide fastener elements is transmitted to the adjacent body portion to which the elements are attached

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rendering the tubing or other product unmerchantable as a first quality product. If the product being made is plastic tubing, the desired gas and liquid-tight seam is found to be defective and unreliable for its intended purposes owing to the opportunity for the admission of moisture, liquids and gaseous fluids as well as the premature and unpredictable opening of the tubing during handling and otherwise. Various expedients employed heretofore to correct the foregoing and other difficulties have met with indifferent success.

It has been discovered that undulations, curling and distortions characteristic of seams formed in plastic materials are due in many instances to the non-uniform localised extrusion and elongation of the material at the seam incident to the formation of the seam by heat and slight pressure. Thus, the heating of the material along the seam opens this material with the result that the application of welding pressure to integrate the two heated surfaces causes minor thinning and elongation of the softened plastic. This lengthening of the material occurs primarily lengthwise of the seam. Material immediately to either side of the seam is heated only slightly and is not lengthened.

It follows that the fuse seaming of plastic material inherently introduces internal stresses and tendencies of the material to curl and warp. If the two components being welded together are identical or substantially so, the distorted condition is restricted to the fused area of the seam and is not noticeable except upon close inspection. Where, however, the materials being fused together have materially different shore hardness characteristics, there is a substantial differential elongation of the two components along the seam and the adjacent area. In consequence, there is produced a very decided distortion of the material, the degree of which is largely dependent on the difference in shore hardness of the components.

The described problem is particularly acute in the assembly of slide fastener tapes to the opposite edge areas of plastic stripping as, for example, in the manufacture of longitudinally-seamed plastic tubing. To provide effective holding power, interlocking slide fastener tapes of the type used for this purpose should have a shore hardness ranging between 85 and 95, whereas the plastic stripping commonly used to form the body of the tubing should be pliant and supple with a shore hardness ranging between 60 to 80. This discrepancy in shore hardness of the two principal components results in the disproportionate elongation and associated distortion of the main body strip relative to the much harder slide fastener tapes fused thereto. Accordingly,

comparatively straight and flat components entering the assembly operation as made by prior heat sealing techniques produce a commercially unsatisfactory product disfigured by curled and undulating edges.

The method of the invention may be used with advantage in a method of fabrication of continuous tubing tape adapted to be assembled into a tube in which a pair of complementary slide fastener tapes having interlocking faces are fused to an elongated strip of plastic material having a lower shore hardness than the slide fastener tapes at or near the longitudinal edges of the strip so that when the tubing is curled transversely thereof, the interlocking faces may engage one another whereby a tube is formed by the tubing tape. Such a method of fabrication is hereinafter referred to as "a method of fabrication of tubing tapes as set forth".

According to another aspect of the invention a method of fabrication of tubing tape as set forth is characterised in that the strip is precooled prior to fusion to stiffen in and in that the fastener tapes are fused to the strip while the latter is in the precooled condition. The slide fastener taping may be pretreated prior to assembly to the plastic main body of the tubing in a manner substantially relieving internal stresses within the webs of the tapes. This is conveniently followed by slitting the tape from the edge of its attaching web to isolate stress areas from one another longitudinally of the tape. The tape may then be placed under slight tension as it is advanced through a sealing station where the portion thereof to be fused to another component is pressed into pressure contact with the component along the line of assembly while being heated to an appropriate heating sealing temperature simultaneously with the preprocessing of the slide fastener tapes.

The degree of cooling of the strip is of considerable importance and best results are obtained when the strip is cooled to stiffen the strip temporarily to exhibit a shore hardness comparable to that of the slide fastener tapes at the moment the seam therebetween is formed. To this end the body strip may be slightly over cooled to compensate for any temperature occurring between the cooling chamber and the heat sealing station normally removed some distance away. A convenient method for so treating the body strip is to pass the strip through a chilling chamber immediately before advancing the stiffened strip to the heat sealing station. In consequence, it is found that the strip not only retains its desired shape and facilitates the handling and feeding of the strip with its lateral edges held uniformly in a desired assembly position with an accuracy greater than in commercial processes known hereto-

fore but, additionally, distortion due to unequal flow of the seam areas fusion are entirely or almost entirely avoided. Furthermore, it is found that the prechilling of the strip provides a stronger and more uniform heat seal, and there is less tendency for the plastic material immediately adjacent the weld to be thinned objectionably during the sealing process.

- 10 An optional feature of the improved tubing product provided by the assembly technique constituting the present invention is the spacing of at least one of the slide fastener tapes from the longitudinal edge of the strip so as to provide a guard flap integral with the main body of the tubing and positioned to underlie, preferably completely, the slide fastener tapes when interlocked to form a seam. This guard flap substantially prevents objects enclosed within the tubing from entering between the slide fastener tapes during the closing operation or from thereafter entering the joint and forcing the tapes apart. The flap also guards against the accidental entrance of seam sealing solvent onto the contents of the tubing as, for example, onto the insulation of wiring.

- 30 According to yet another aspect of the invention there is provided apparatus for continuously carrying out the invention as set out above comprising fusing means for fusing the two components together, first feed means for feeding the component of higher shore hardness to the fusing means, cooling means for cooling the component of lower shore hardness and second feed means for feeding the component of lower shore hardness from the cooling means to the fusing means.

40 In the accompanying drawings in which a preferred embodiment of the invention is illustrated:

- 45 Figure 1 is a schematic view in perspective of a preferred mode of straightening deformed plastic slide fastener tapes;

- 50 Figure 2 is a schematic view in perspective of the principal components employed in the assembly of continuous plastic tubing and of suitable mechanical aids useful in pretreating and in effecting the assembly of the components thereof;

- 55 Figure 3 is a view in perspective of the tubing during its assembly about a bundle of wires; and

Figure 4 is an enlarged fragmentary view in transverse section through the slide fastener seam after assembly and showing the position of the guard flap thereacross.

- 60 Referring to the drawings and more particularly to Figures 1 and 2, there is shown the principal equipment components employed to fabricate plastic tubing according to one method of practicing the present invention, this equipment being designated

generally 10. The equipment includes an elongated oven 11 having an open-ended tunnel 12 for the passage therethrough of at least one pair of plastic slide fastener tapes 13 and 14. The oven is provided interiorly thereof with any suitable heating elements controlled in any conventional manner to heat the plastic tapes almost to the point where the plastic material starts to flow or stretch, it being understood that the particular operating temperature will vary in accordance with the speed at which the tapes are passed through the oven. The tape to be processed may be supported by suitable guide rollers or by a conveyor. It will be noted that the unprocessed tape entering the oven from the right has very irregular wavy webs characteristic of presently available commercial plastic tape. Tapes 13 and 14 are here shown as assembled to one another on entering oven 11 as this is found of convenience in the handling of the tapes, although it is not essential to the process.

As the tapes leave the exit end of tunnel 12, they are quite hot and soft and, for this reason, the webs stretch readily to the slight extent found desirable and necessary to relieve stresses in the tapes and enabling the tapes to lie in a straight, flat condition. Such straightening is aided materially by the slight tension required to feed the tape through the oven. To provide further assurance against subsequent warping and curling of the tape webs as they cool, the wide flat webs 15 and 16 are subjected to a further and important slitting step as the webs pass between pairs of slitter rollers 19 and 20. At least one roll of each pair is provided with diagonal knives 21 which act to slit the webs 15 and 16 along lines 22 preferably lying at an angle to the edges of the webs. Slits 22 will be recognized as isolating adjacent portions of the web from one another as respects the transmission of internal stresses within the tape webs without, however, materially affecting the strength of the webs. This is particularly true after all portions of the tape webs have been fused to the plastic main body of the tubing as will be explained presently. Although not so shown, it will be understood that suitable drive means is connected to rollers 19 and 20 and they may be employed to advance the tape being treated through the oven and past the slitters.

After the tape has been treated as described, it is cooled and the two halves are separated from one another preparatory to their fusion to the opposite lateral sides of the tubing body web. Although tapes 13 and 14 are not here illustrated as feeding directly into the tubing assembly equipment, it will be understood that it is a matter of choice whether the tapes are processed simultaneously with the assembly of processed

portions thereof to the tubing body or whether the stress-relieving operation is performed separately from the assembly operation. Either mode of operation is feasible.

5 It will, of course, be recognised that the straightened and stress-relieved tapes can be twisted or otherwise properly oriented as may be desirable for assembly to the tubing body.

10 Referring now to Figure 2, the equipment preferably employed in the assembly of plastic tubing comprises a suitable pre-chilling chamber designated generally 23 having narrow slots 24 across its opposite ends through which the main body strip of thin plastic material 32 is fed while being advanced to the heat sealing station. Chilling chamber 23 may be provided with rollers, flat opposed shoes, flat springs and the like
15 located against the opposite faces of plastic strip 32 and co-operating to hold the strip flat and straight while being chilled and stiffened. Any suitable chilling means may be used for cooling strip 32 to the extent
20 found effective in stiffening the strip to the extent required to bring the shore hardness thereof temporarily into harmony and equality with the shore hardness of webs 15 and 16 of tapes 13 and 14 when in welding position between the welding electrodes 27,
25 28. Since at normal room temperature the shore hardness of the slide fastener tapes is desirably within the range of 85 to 95 to provide the interlocking tongues and grooves thereof with adequate holding power, it is preferable to pre-cool only stripping 32 and not the tape webs. Slight excess cooling of strip 32 is desirable to compensate for heat gain while advancing the strip to the
30 heat sealing station, the object being to present the parts to be fused together at the sealing station with substantially uniform shore hardness characteristics during the brief interval required for this operation so that substantially uniform thinning of the seam areas occurs in both components.

35 In some cases owing to the particular characteristics of the different plastic materials being joined, equal lengthening of the components lengthwise of the seam may require the differential pre-cooling of both components, or the heating of one and the cooling of the other, and/or the provision of temporary non-equivalent shore hardness characteristics in the parts joined. It is, therefore, to be understood that a flat and undistorted seam between plastic materials of differing characteristics can be achieved according to this invention by the proper
40 differential temperature conditioning of the components immediately prior to the junction thereof by heat sealing.

45 The stiffened strip 32 is advanced directly from chilling chamber 23 into grooves 26 provided in the edges of a pair of parallel

tape guide members 25, 25 formed of electrically non-conductive material. The grooves 26 are of a size suitable for receiving and positioning the relatively thick tongue and groove sections 17 and 18 of the tapes while leaving the web portions 15 and 16 fully exposed and extending toward one another in the same plane. Guide strips 25 are suitably supported for adjustment toward or away from one another to accommodate the assembly equipment to the processing of tubing of different widths.

50 Fusion of the tape webs to pre-cooled and stiffened strip 32 is preferably accomplished by the aid of two pairs of heating and pressing electrodes 27, 28. The upper pair 27 of these electrodes is carried by vertically reciprocal supporting rods 29 by which these electrodes can be raised or lowered relative to the stationary lower pair of electrodes 28, 28. Metal electrodes 27 and 28 have smooth flat opposed surfaces and are connected in circuit as by wires 30, 30 with a high frequency generator. This assures that heating takes place primarily in the area between the electrodes with the electrodes proper remaining relatively cool.

55 Strip 32 of the width desired for the body of the tubing is fed lengthwise of electrodes 28 with one edge 33 lying between the inner end of slits 22 and the tongue and groove portion 17 of tape 15. The other lateral edge 34 of the tape preferably extends well beyond the outer lateral edge of the tongue and groove portion 18 of tape 16 so as to form a sealing flap 35 for the finished tubing, this flap lying flat in the deep bottom portion of groove 26 in the adjacent guide member 25 during the assembly operation.

60 The assembled tubing tape is advanced intermittently as by rubber-covered feed rollers 37, 38 rotating in opposite directions, the individual increments of advance being limited to the length of electrodes 27, 28 and being carried out while the electrodes are held separated and de-energised. Following this advance, the electrodes are lowered to press the tape webs to the underlying portions of the still cold and stiff strip 32. The high frequency generator is then energised heating the contacting areas of the plastic elements to a fusion heat at which time the current flow is discontinued, preferably automatically, as the electrodes remain gently pressed together until the parts are firmly fused together, the time interval for the pressing operation being approximately one-half that required for heating. The described heat sealing operations are preferably performed in accurately-timed relationship synchronized with the intermittent advance of the strip and of the tapes, an operation which may be accomplished either manually or automatically, the latter being preferred inasmuch as it does

not require attention by the operator or manual operations of any kind. However, for special runs or for reasons of economy, the tapes can be hand-fed beneath the electrodes and any one or more of the other operations can also be performed by manual manipulations.

It is found that minor lengthwise adjustments of the tape webs 15 and 16 required for purposes of stress compensation and the correction of curling, twisting and the like, is facilitated by slits 22. This corrective action is further facilitated if the slits are made at an angle to the web surfaces, though such inclination is not essential to the slight overriding of the slit edges taking place as a part of the corrective action during the assembly and heat sealing operation.

Finished tubing tape discharging from feeding rolls 37 and 38 may be wound flat on a shipping spool 40 for compact packaging. Spools 40 may be provided with side flanges protecting the exposed edges of the tubing from injury during subsequent handling and shipping.

The finished tubing tape designated generally 42 is provided with a suitable slide device 43 and is shown in Figure 3 in the process of being assembled about a group of electric wires 44, only a small number of the wires being shown. It will be understood that tubing 42 can be made of any desired width to enclose snugly a bundle of wires 44 of any size. Slide device 43 comprises a slider proper 45 having a pull member 46 slidable along a retaining web 47 in accordance with conventional practice. It will be recognized that the slide member is formed to fit over the tongue and groove sections 17, 18 of the slide fastener tapes and is suitably shaped interiorly thereof to guide these members into and out of interlocking engagement depending upon the direction in which the slide device is pulled lengthwise of the tube.

Figure 4 is an enlarged view showing a particularly suitable form of interlocking tongue and groove design for the slide fastener tapes. Note that each tape is provided with a pair of longitudinal grooves 48 shaped to receive and closely interfit with the complementarily shaped tongues 49 of the other tape. It will be recognized that the particular shape of the slide fastener elements may be of any other suitable form although one is preferred in which the engaging elements mutually co-operate to provide a fluid and moisture proof seal when nested together.

Desirably, flap 35 completely bridges the slide fastener tapes and overlaps slightly with the opposite lateral edge 33 of the plastic body 32 of the tube. Accordingly, this flap underlies the closure slide device 43 and therefore co-operates in providing

a complete enclosure for the wires independently of the slide fastener tapes and aids not only in the expeditious closure of the tapes but in preventing stray wires from flexing outwardly into the path of slide device 43 as it is being closed. The flap also tends to prevent dirt and foreign matter from entering the grooves of the slide fastener during the closing operation, an occurrence leading to the malfunctioning and the improper closure of the tubing. Other important functions of the guard flaps are to prevent injury to wiring as the slide device 43 is operated to close the seam and to frictionally hold the seam together when tubing filled with wire is flexed sharply thereby causing the wires to press the flap firmly against the interior walls of the tubing. Additionally, the guard flap safeguards against the entry of the liquid sealing solvent often used in sealing the seam closed. The entry of such solvent could damage plastic insulation covering wires enclosed by the tubing.

The plastic elements may be made from any suitable plastic material of which there are a great variety. Polyethylene and the various vinyls are particularly suitable but are merely mentioned by way of illustrative examples. It is mentioned further that the plastic covering herein described is suitable for many other applications than as a wire harness or enclosure for electrical wiring. For example, the tubing may be used as a covering for piping of all kinds either as a protective and appearance covering or as a means for holding other elements assembled to the pipe such as heat insulation to steam pipes.

Although the fabricating technique provided by the present invention has been described in connection with the production of a specific product of a novel character, it is pointed out that the principles of the invention are applicable generally to the fabrication of numerous plastic articles of manufacture including those wherein it is desirable to form heat fused seals while one or more of the components being joined are retained in a simple or a compound curved position by the pre-cooling thereof while held in the desired curvature. Likewise, the assembly of film-like plastic sheeting is greatly facilitated by pre-cooling the sheeting to stiffen the same before forming heat-fused seams.

While the particular method of fabricating articles from plastic, the apparatus for so doing, and the article formed thereby are herein shown and disclosed in detail, it is to be understood that they are merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construc-

tion or design herein shown other than as defined in the appended claims.

WHAT I CLAIM IS:—

1. A method of fusing together two plastic components having differing shore hardness characteristics comprising cooling the component of lower shore hardness and then heat sealing the two components together while the component of lower shore hardness is in the cooled condition.
2. A method as claimed in Claim 1 wherein the component of lower shore hardness is cooled sufficiently so that the shore hardness of the two components are substantially equivalent during fusion.
3. A method of fabrication of tubing tape as set forth characterised in that the strip is pre-cooled prior to fusion to stiffen it and in that the fastener tapes are fused to the strip while the latter is in the pre-cooled condition.
4. A method as claimed in Claim 3 wherein the strip is held flat during pre-cooling.
5. A method as claimed in Claim 3 or Claim 4 wherein the fastener tapes are heated prior to fusion to relieve internal stresses.
6. A method as claimed in Claim 5 wherein the fastener tapes are interlocked during heating to relieve internal stresses.
7. A method as claimed in Claim 5 or Claim 6 wherein the tapes are maintained flat and extended after the said heating until the tapes are cool.
8. A method as claimed in Claim 5, Claim 6, or Claim 7 for fabricating tubing tape in which the fastener tapes are provided with webs whereby they are fused to the strip and wherein the webs are slitted transversely of the webs after heating to relieve internal stresses and before fusion.
9. A method as claimed in Claims 7 and 8 wherein the webs are slit after they have cooled.
10. A method as claimed in Claim 8 or Claim 9 wherein the fastener tapes are held flat and straight during fusion.
11. A method as claimed in Claim 10 wherein the fastener tapes have a tension applied to them during fusion sufficient to hold them straight.
12. A method as claimed in any one of preceding Claims 3 to 11 wherein at least one of the fastener tapes is fused to the strip inwardly of one lateral edge to provide a flap which underlies the slide fastener tapes when the tube is assembled.

13. A method as claimed in Claim 12 wherein the flap is sufficiently wide to overlap the opposite lateral edge of the strip when the tube is assembled.
14. A method of fabrication of tubing tape as set forth in which the fastener tapes are provided with webs whereby they are fused to the strip and wherein the webs are slitted transversely of the webs after heating to relieve internal stresses and before fusion.
15. A method of fusing together two plastic components substantially as hereinbefore described with reference to the accompanying drawings.
16. An article comprising two plastic components having differing shore hardness characteristics fused together by the method claimed in Claim 1, 2 or 15.
17. Tubing tape when made by the method claimed in any one of Claims 3 to 14.
18. Tubing tape made substantially as hereinbefore described with reference to Figures 2, 3 and 4 of the accompanying drawings.
19. Apparatus for continuously carrying out the invention as claimed in Claim 1 comprising fusing means for fusing the two components together, first feed means for feeding the component of higher shore hardness to the fusing means, cooling means for cooling the component of lower shore hardness and second feed means for feeding the component of lower shore hardness from the cooling means to the fusing means.
20. Apparatus as claimed in Claim 19 for carrying out the method of Claim 3 wherein the fusing means is provided with support means for holding the slide fastener tapes flat and straight and positioned in superimposed relation along laterally spaced positions over the strip, the said support means being adapted to expose only those parts of the slide fastener tapes held thereby to which fusing means is to be applied.
21. Apparatus as claimed in Claim 20 wherein the fusing means comprises at least one heat sealing electrode for each slide fastener tape.
22. Apparatus substantially as hereinbefore described with reference to and as illustrated in Figures 1 and 2 of the accompanying drawings.

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COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of
the Original on a reduced scale

